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### Self-Organizing-Map Program for Analyzing Multivariate Data

SOM\_VIS is a computer program for analysis and display of multidimensional sets of Earth-image data typified by the data acquired by the Multi-angle Imaging Spectro-Radiometer [MISR (a spaceborne instrument)]. In SOM\_VIS, an enhanced self-organizing-map (SOM) algorithm is first used to project a multidimensional set of data into a nonuniform three-dimensional lattice structure. The lattice structure is mapped to a color space to obtain a color map for an image. The Voronoi cell-refinement algorithm is used to map the SOM lattice structure to various levels of color resolution. The final result is a false-color image in which similar colors represent similar characteristics across all its data dimensions. SOM\_VIS provides a control panel for selection of a subset of suitably pre-processed MISR radiance data, and a control panel for choosing parameters to run SOM training. SOM\_VIS also includes a component for displaying the false-color SOM image, a color map for the trained SOM lattice, a plot showing an original input vector in 36 dimensions of a selected pixel from the SOM image, the SOM vector that represents the input vector, and the Euclidean distance between the two vectors.

*This program was written by P. Peggy Li, Joseph C. Jacob, Gary L. Block, and Amy J. Braverman of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

*This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (818) 393-2827. Refer to NPO-40666.*

### Tool for Sizing Analysis of the Advanced Life Support System

Advanced Life Support Sizing Analysis Tool (ALSSAT) is a computer model for sizing and analyzing designs of environmental-control and life support systems (ECLSS) for spacecraft and surface habitats involved in the exploration of Mars and Moon. It performs conceptual designs of advanced life support (ALS) sub-

systems that utilize physicochemical and biological processes to recycle air and water, and process wastes in order to reduce the need of resource resupply. By assuming steady-state operations, ALSSAT is a means of investigating combinations of such subsystems' technologies and thereby assisting in determining the most cost-effective technology combination available. In fact, ALSSAT can perform sizing analysis of the ALS subsystems that are operated dynamically or steady in nature. Using the Microsoft Excel® spreadsheet software with Visual Basic programming language, ALSSAT has been developed to perform multiple-case trade studies based on the calculated ECLSS mass, volume, power, and Equivalent System Mass, as well as parametric studies by varying the input parameters. ALSSAT's modular format is specifically designed for the ease of future maintenance and upgrades.

*This program was developed by Hue-Hsia (Jannivine) Yeh, Cheryl B. Brown, and Frank J. Jeng of Lockheed Martin Corp. for Johnson Space Center. For further information, contact the Johnson Technology Transfer Office at (281) 483-3809.*

MSC-23506

### Control Software for a High-Performance Telerobot

A computer program for controlling a high-performance, force-reflecting telerobot has been developed. The goal in designing a telerobot-control system is to make the velocity of the slave match the master velocity, and the environmental force on the master match the force on the slave. Instability can arise from even small delays in propagation of signals between master and slave units. The present software, based on an impedance-shaping algorithm, ensures stability even in the presence of long delays. It implements a real-time algorithm that processes position and force measurements from the master and slave and represents the master/slave communication link as a transmission line. The algorithm also uses the history of the control force and the slave motion to estimate the impedance of the environment. The estimate of the impedance of the environment is used to shape the controlled slave impedance to match the transmission-line impedance. The estimate of the environmental impedance is used to match the master and transmission-line impedances and to estimate the slave/environment force in order to present that force immediately to the operator via the master unit.

*This Robert J. Kline-Schoder and William Finger of Creare, Inc., for Johnson Space Center. For further information, contact the Johnson Technology Transfer Office at (281) 483-3809.*

MSC-23412

### Java Radar Analysis Tool

Java Radar Analysis Tool (JRAT) is a computer program for analyzing two-dimensional (2D) scatter plots derived from radar returns showing pieces of the disintegrating Space Shuttle *Columbia*. JRAT can also be applied to similar plots representing radar returns showing aviation accidents, and to scatter plots in general. The 2D scatter plots include overhead map views and side altitude views. The superposition of points in these views makes searching difficult. JRAT enables three-dimensional (3D) viewing: by use of a mouse and keyboard, the user can rotate to any desired viewing angle. The 3D view can include overlaid trajectories and search footprints to enhance situational awareness in searching for pieces. JRAT also enables playback: time-tagged radar-return data can be displayed in time order and an animated 3D model can be moved through the scene to show the locations of the *Columbia* (or other vehicle) at the times of the corresponding radar events. The combination of overlays and playback enables the user to correlate a radar return with a position of the vehicle to determine whether the return is valid. JRAT can optionally filter single radar returns, enabling the user to selectively hide or highlight a desired radar return.

*This program was written by Mariusz P. Zaczek of Johnson Space Center. For further information, contact the Johnson Technology Transfer Office at (281) 483-3809.*

MSC-23742

### Architecture for Verifiable Software

Verifiable MDS Architecture (VMA) is a software architecture that facilitates the construction of highly verifiable flight software for NASA's Mission Data System (MDS), especially for smaller missions subject to cost constraints. More specifically, the purpose served by VMA is to facilitate aggressive verification and validation of flight software while imposing a minimum of constraints on overall functionality. VMA exploits the state-based architecture of the MDS and partitions verification issues